REMARKS

The specification has been amended to correct minor grammatical and typographic errors. In addition, the values of $\theta+\delta$ as a greater angle with respect to vertical θ as a lesser angle with respect to vertical have been stated explicitly in accordance with what is shown in FIG. 3. The claims have been amended in view of the Office action and in view of the remarks which follow, they are believed to be in condition for allowance.

DETAILED ACTION

Claim Rejections - 35 U.S.C. § 103

In section 1 of the detailed action under 35 U.S.C. § 103(a), claims 1, 4, 9 and 12 were rejected as being unpatentable over the admitted prior art in view of Bindal (U.S. patent No. 5,548,148). The Office Action stated as follows:

> "The admitted prior art of Fig. 2A teaches a method of forming a deep trench vertical transistor in a semiconductor substrate having a surface and a deep trench with a sidewall formed in said semiconductor substrate and a bitline diffusion region 26 juxtaposed therewith on the surface of said semiconductor substrate, comprising the steps as follows:
> forming a deep trench having a top and a lower portion in a doped semiconductor substrate 15;
> forming a counterdoped buried plate 42 in said substrate surrounding said lower portion of said deep trench;
> forming a storage node dielectric layer 44 as a conformal thin film on inner walls of said deep trench;
> filling said deep trench with an initial storage node conductor 11 which is counterdoped above and in contact with said initial storage conductor;
> recessing the initial storage conductor, forming a dielectric collar 12 as a conformal film on exposed inner walls of said deep trench with said dielectric collar recessed below said top of said deep trench;
> filling said deep trench with a complementary storage node conductor which is counterdoped above and in contact with said initial storage conductor;
> recessing said complementary storage node conductor to a buried strap level 13 in said deep trench;
> forming a counterdoped buried strap OD counterdoped out-diffusion by diffusion of dopant from said complementary storage node conductor into said substrate;
> forming a trench top oxide layer 14 over said complementary storage node conductor;
> forming a gate oxide layer 24 which is conformal with exposed inner walls of said deep trench;
> forming a gate conductor 16 in said deep trench above said trench top oxide layer;
> recessing the gate conductor below the surface of said semiconductor substrate; and
> performing angled ion implantation at an angle e with respect to vertical of a p-type dopant into said channel below the location of said bit line diffusion region (drain region).
> "The admitted prior art differs from the claims in not having the step of performing angled ion implantation at an angle $\theta+\delta$ with respect to vertical of a counterdopant into said channel below the location of said drain region."

"Bindal teaches that when p-type dopant (boron) implanted into a channel region of an N-channel MOSFET is compensated or counterdoped with arsenic results in high threshold voltage while reducing substrate sensibility and source/drain junction capacitance (col. 1, lines 40-55, col. 2, lines 51-60). The dopant and counterdopant are implanted at an angle of 7 degrees (col. 4, line 66)."

"It would have been obvious to one of ordinary skill in the art at the time the invention was made to counterdoping the implanted p-type dopant of Fig. 2A by performing angled ion implantation at an angle of 7 degrees with respect to vertical of arsenic because the counterdoping would have the benefits as suggested by Bindal. Note that, since the claims do not limit to any value of δ, the claims are met when δ is zero.

The specification and the drawings of the application, as filed, clearly teach that the angle $\theta+\delta$ is a greater angle than the angle θ as can be seen in FIG. 3 of the instant application. In view of the rejection, the claims and specification have been amended to make it crystal clear that "δ" is greater than zero since FIG. 3 makes it clear that $\theta+\delta$ is a greater angle with respect to vertical and that θ is a lesser angle with respect to vertical, and as described in the amended specification. The prior art cited does not suggest performing angled ion implantation of a counterdopant into the channel below the location of the drain region at a greater angle $\theta+\delta$ with respect to vertical; and performing angled ion implantation of a dopant into said channel below said location of the drain region at a lesser angle θ with respect to vertical.

In section 2 of the detailed action , under 35 U.S.C. 103(a), claims 2-3, 5-8, 10-11, 13-20 were rejected as being obvious over the admitted prior art taken with Bindal as stated above and further in view of Chidambarrao et al. (US 6,740,920). The Office Action stated as follows:

"The applied reference has a common inventor with the instant application. Based upon the earlier effective U.S. filing date of the reference, it constitutes prior art only under 35 U.S.C. 102(e). This rejection under U.S.C. 103(a) might be overcome by: (1) a showing under 37 CFR 1.132 that any invention disclosed but not claimed in the reference was derived from the inventor of this application and is thus not an invention "by another"; (2) a showing of a date of invention for the claimed subject matter of the application which corresponds to subject matter disclosed but not claimed in the reference, prior to the effective U.S. filing date of the reference under 37 CFR 1.131; or (3) an oath or declaration under 37 CFR 1.130 stating that the application and reference are currently owned by the same party and that the inventor named in the application is the prior inventor under 35 U.S.C. 104, together with a terminal disclaimer in accordance with 37 CFR 1.321(c). For applications filed on or after November 29, 1999, this rejection might also be overcome by showing that the subject matter of the reference and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person. See MPEP § 706.02(l)(1) and § 706.02(l)(2)."

A statement by the undersigned, who is an attorney of record can be found below which rejection under U.S.C. 103(a) in view of Chidambarrao et al. (US 6,740,920) reference) is overcome.

The Office Action stated further as follows:

> "The combination of the admitted prior art and Bindal teaches a method as described above. The combined teaching differs from the claims in not disclosing recessing the gate conductor 16 below the bottom level of the source region 26 (see Fig. 2A)."
>
> "Chidambarrao teaches that when the angled threshold implantation of boron is performed only in the upper portion of the channel toward the source results in the region of the channel near the drain region has a lower concentration of dopant than the portion toward the source so that there is less leakage at the channel-drain junction and so that hot-electron effects are reduced (Fig. 4 and col. 4, lines 39-45)"
>
> "It would have been obvious to one of ordinary skill in the art to modify the admitted prior art by recessing the gate conductor 16 below the bottom level of the source region 26 because this would allow the threshold implantation only in the upper portion of the channel toward the source while keeping dopant concentration low in the region of the channel near the drain as suggested by Chidambarrao. The motivation of doing so is to prevent leakage at the channel-drain junction and reduce hot-electron effects as taught by Chidambarrao."
>
> "As for claims 3, 6, 8, 11, 14, 16, 18, and 20, Chidambarrao teaches an angle of between 7-20 degrees for the dopant implant and Bindal teaches dopant and counterdopant could be performed at the same angle, hence the determination of values for θ and δ within said range so as to satisfy the condition as claimed would have been obvious to one skilled in the art since it has been held that, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable range by routine experimentation. *In re Aller*, 220 F.2d 454, 456,105 USPQ 233, 235 (CCPA 1955). *In re Kulling*, 897 F.2d 1147, 14 USPQ2d 1056 (Fed. Cir. 1990); and *In re Geisler*, 116 F.3d 1465, 43 USPQ2d 1362 (Fed. Cir. 1997)." [Italics added]

The undersigned who is an attorney of record appointed in the "Declaration and Power of Attorney for Patent Application" filed in this application hereby states that the instant application filed on 18 August 2003 (after November 29, 1999) and the Chidambarrao et al. reference issued on May 25, 2004 were at the time the invention was made, owned by, or subject to an obligation of assignment to the assignee of the instant application. Accordingly the ground of rejection over the combination of Bindal and the Chidambarrao et al references is believed to have been overcome.

In view of the amendments and the above remarks, the grounds of rejection are believed to have been overcome. Accordingly, the claims are now believed to be patentable over the prior art of record.

No fee is believed to be due for the submission of this amendment. If any fees are required, however, please charge such fees to Deposit Account No. 09-0458.

In view of the amendments and the above remarks favorable action including allowance of the claims and the application as a whole are respectfully solicited.

Respectfully submitted,

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